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26 WEST 61ST STREET	TAVLYKAEV, ROBERT FUATOVICH			
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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<b>Office Action Summary</b>	<b>Application No.</b> 10/581,849	<b>Applicant(s)</b> LEISING ET AL.
	<b>Examiner</b> ROBERT TAVLYKAEV	<b>Art Unit</b> 2883

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
  - If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
  - Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED. (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) Responsive to communication(s) filed on 28 July 2009.
- 2a) This action is FINAL.      2b) This action is non-final.
- 3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) Claim(s) 21-23,26-28,30,32,34 and 42-49 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) Claim(s) \_\_\_\_\_ is/are allowed.
- 6) Claim(s) 21-23,26-28,30,32,34,42-49 is/are rejected.
- 7) Claim(s) \_\_\_\_\_ is/are objected to.
- 8) Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) The specification is objected to by the Examiner.
- 10) The drawing(s) filed on \_\_\_\_\_ is/are: a) accepted or b) objected to by the Examiner.  
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) All    b) Some \* c) None of:
1. Certified copies of the priority documents have been received.
  2. Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |  |   |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892)                     | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date _____                                       |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)          | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____  | 6) <input type="checkbox"/> Other: _____                          |

**DETAILED ACTION**

1. The Applicant's RCE and remarks/arguments filed 7/28/09 are acknowledged. Claim 21 has been amended; and claims 1 – 16 and 38 – 41 cancelled. Claims 21 – 23, 26 – 28, 30, 32, 34, 42 – 49 are pending.

*Response to Arguments*

2. The submitted corrections of dependency of claims 32, 45, and 46 have been fully considered and the objections have been withdrawn.

3. The Applicant's arguments regarding rejections under 35 USC 103(a) have been fully considered but they are moot in view of the new grounds of rejection, as necessitated by the Applicant's amendments. The new grounds of rejection are applied using the previously cited prior art, including a reference by Maruo et al cited in the Office Action of 2/19/09.

*Claim Rejections - 35 USC § 112*

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 21 recites the limitation "to displace the focal area of the emitted laser beam, in the plane of said printed circuit board element, and adjusting the focal area also in terms of depth within the optical layer". There is insufficient antecedent basis for this limitation in the claim. For the purposes of this Action, the limitation is interpreted as – to displace a focal area of an emitted laser beam, in a plane of said printed circuit board element, and adjusting the focal area also in terms of a depth within the optical layer. Appropriate corrections are required.

***Claim Rejections - 35 USC § 103***

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

7. **Claims 21 – 23, 26, 27, 32, 42 – 46, and 48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iwaki et al (US Pub. No. 2004/0001661 A1) in view of “Three-**

**dimensional microfabrication with two-photon-absorbed photopolymerization," by Maruo et al, Optics Letters, vol. 22, No. 2, Jan 1997, pp. 132 – 134 (hereinafter Maruo).**

Regarding claim 21, Iwaki discloses (e.g., Figs. 1 and 15) a printed circuit board (PCB) element including at least one optical waveguide (105) provided in an optical layer (106/104) and at least one optoelectronic component (103) that is in optical connection with the optical waveguide (105) and embedded in the optical layer (106). Iwaki states (par. [0048] and [0054]) that the optical waveguide (105) can be formed/structured by photon (UV) irradiation within the optical layer (106), the latter being formed of a photorefractive material. Iwaki cites (par. [0054]) that the refractive index of the photorefractive material changes (increases) under photon irradiation, thereby producing an optical waveguide structure (comprising an optical waveguide core that provides light confinement) surrounded by the remaining optical layer and adjoining the optoelectronic component (103).

Figs. 7A – 7I of Iwaki show steps of a method for producing a PCB element. In particular, the disclosed method produces a PCB element having recesses to be filled with a light transmitting resin (109) (par. [0055]). Iwaki does not directly illustrate a method for producing a printed circuit board element without recesses (e.g., the PCB element shown in Fig. 1). However, the teachings of Iwaki would have made it obvious to a person of ordinary skill in the art that the printed circuit board element shown in Fig. 1 can be produced using the following sequence: (a) the step shown in Fig. 7D, which illustrates a step of mounting at least one optoelectronic component, e.g., (103) to a substrate (119); (b) the step shown in Fig. 7B, which illustrates a step of applying an optical layer (106) to the substrate (119), the optical layer being comprised of an optical material changing its refractive index upon photon irradiation. Without

the recesses shown in Fig. 7b and the optoelectronic component (103) already mounted to a substrate (119), the optical layer (106) would embed the optoelectronic component (103); (c) the step shown in Fig. 7A, which illustrates a step of producing, by photon irradiation, a waveguide structure (105) in the optical layer (106), the waveguide structure being surrounded by the remaining optical layer (106), in order to adjoin the optoelectronic component (103). The motivation for using a method with such step sequence is that it is a simplest and shortest sequence that can be used to produce the PCB element shown in Fig. 1 of Iwaki, since the extra processing steps related to the formation of recesses are not needed. Therefore, production costs can be reduced – indeed, the additional steps (which are shown in Figs. 7A – 7I and needed for the more complicated (with recesses) PCB element in Fig. 2) would be superfluous for the PCB element shown in Fig. 1.

Iwaki does not detail apparatus that can be used for UV writing, even though such apparatus is well known in the art. In this regard, Maruo describes an apparatus and a corresponding method of UV writing (photon irradiation) of volumetric structures in a photorefractive material whose refractive index changes upon photon irradiation. In particular, Fig. 2 of Maruo illustrates that there are an optical vision unit (comprising a CCD camera and a monitor) and a radiation unit, the latter including a lens system (comprising a lens with a NA of 0.85). The optical vision unit is used to control (via a computer) a three-dimensional position of an emitted laser beam that is focused by the lens system within an optical layer of a photo-polymer material. The control is done by moving the optical layer with respect to the focused beam so as to displace a focal area of the emitted laser beam in a plane normal to the beam and to adjust the focal area in terms of a depth within the optical layer. It is obvious from Fig. 2 that,

alternatively or additionally to moving the optical layer, the focused beam can be moved with respect to the optical layer in order to form a 3D object, e.g., a lightwave guide (page 132, 1<sup>st</sup> par.). Therefore, it would have been obvious to a person of ordinary skill in the art that the waveguide disclosed by Iwaki can be formed through the sequence of the recited method steps by using the well-known apparatus illustrated by Maruo. It is also noted that even though Maruo does not expressly state how focusing and initial positioning of the focused beam is done, it is well known in the art and would have been obvious to a person of ordinary skill in the art that any object within the optical layer, e.g., the optoelectronic component disclosed by Iwaki, can be used by the optical vision unit in order to determine/establish a reference position and optimize focusing for the laser radiation unit. The benefit of optical vision control is that an optical waveguide of any desired 3D shape can readily/reproducibly be formed, including aspheric surfaces for improving optical coupling between the waveguide and the optoelectronic component (par. [0048] of Iwaki) or even more complex surfaces shown in Fig. 4 of Maruo, which can enable PCB elements with a plurality of optical connections in different planes/directions.

Regarding claim 22, Fig. 1 of Iwaki shows two optoelectronic components (i.e., parts (101) and (103)), which are embedded in the optical layer (106) and thereafter are connected with each another by the optical waveguide (105) directly adjoining the same. It would have been obvious to a person of ordinary skill in the art that the board element in Fig. 1 may have a substrate, which is used for mounting the two optoelectronic components and disposed similarly

to the substrate (129a) in Fig. 6, in order to increase the mechanical stability / rigidity of the board element (see paragraph [0059] of Iwaki).

Regarding claim 23, Fig. 7B of Iwaki shows that after the production of the optical waveguide structure (105) in the optical layer (106), a printed circuit board layer (119) including a conductive inner ply (comprising the parts (121a) and (121c)) is applied to at least one side of the optical layer (106).

Regarding claim 26, Fig. 6 of Iwaki shows that vias (comprising (140) and (125)) are provided in the optical layer (104) and in the printed circuit board layer (129a), in coordination with the respective optoelectronic component (103), and that electrically conductive connections to the optoelectronic component can be established through the vias.

Regarding claim 27, Fig. 8 of Iwaki shows that the optoelectronic component (103) is conductively connected with an associated electronic component, i.e. a driving part (113). Fig. 8 does not explicitly show a printed circuit layer or a substrate. However, it would have been obvious to a person of ordinary skill in the art that there can be a printed circuit layer (which is included between the part (113) and the optical layer (106) and is used for mounting the part (113)), because Iwaki illustrates such a printed circuit layer in Fig. 6 and teaches that this arrangement is desirable as providing increased mechanical stability/rigidity of the entire printed circuit board element (par. [0059] of Iwaki).

Regarding claims 42 and 43, Figs. 6 and 7B of Iwaki show that the inner ply (comprising the parts (121a) and (121c)) may be patterned before applying the printed circuit board layer ((119) or (129a)) to the optical layer (104). Figs. 6 and 7H - 7I show that the outer ply (comprising (121b) or (141)) can be patterned after such application.

Regarding claim 44, Iwaki teaches (par. [0085]) that the disclosed printed circuit board element can include multilayer boards on one of both sides of the optical layer. Two or more layers in a multilayer board can represent a cover layer and a substrate with the cover layer being provided before applying the optoelectronic component thereto.

Regarding claims 32, 45, and 46, Fig. 6 of Iwaki shows that electrical connections for the optoelectronic components (103) and (101) are established throughout an electrically conductive distribution layer (comprising parts (121a) and (121c)), the distribution layer being configured as a heat-dissipation layer. Fig. 6 makes it obvious that the distribution layer can be applied to a substrate (129a) and subsequently patterned.

Regarding claim 48, Fig. 15 of Iwaki discloses an optical waveguide (105) provided with a lens structure (109) on its end adjacent an optoelectronic component (101), the latter being a light reception device. The lens structure at least partially encloses the optoelectronic component (101) and is used for focusing light into the optoelectronic component (101). The focusing property depends on the refractive index of the material used to form the lens structure (109). Iwaki does not explicitly state that the lens structure (109) can be made a part of the optical waveguide (105). However, Iwaki does cite (see paragraph [0098]) that the refractive index of the material should be higher than that of the optical layer (104). Thus, it would have been obvious to a person of ordinary skill in the art that the material of the optical waveguide (105) can be used to form the lens structure (109) and be integral with it, since the refractive index of optical waveguide (105) satisfies the above condition. The motivation for forming the lens structure (109) as a part of the optical waveguide (105) is that such a structure would have a

reduced the number of needed materials, can be produced in a single step, and reduces cost, while still providing the benefit of an improved light collection efficiency.

**8. Claims 28 and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iwaki et al (US Pub. No. 2004/0001661 A1) in view of “Three-dimensional microfabrication with two-photon-absorbed photopolymerization,” by Maruo et al, Optics Letters, vol. 22, No. 2, Jan 1997, pp. 132 – 134 (hereinafter Maruo), as applied to claims 21, 44, and 45 above, and further in view of Yoshimura et al (US Patent No. 6,684,007 B2).**

Regarding claim 28, Fig. 8 of Iwaki shows that the optoelectronic component (103) is used with an associated electronic component, i.e. a driving component (113). In Fig. 8, the driving component (113) is shown to be positioned on one side of the board. However, Iwaki’s invention also includes an embodiment, wherein the driving device (113) is arranged inside the board (par. [0085]), thus making it an embedded unit. The optoelectronic component (103) (e.g., a light emission device (see paragraph [0046])), if combined with the driving component (113) (i.e. an electronic driver), is an optoelectronic chip. Therefore, the Iwaki – Maruo combination (see the arguments and motivation for modification as applied to claim 21 above) teaches all of the subject matter, except for stating that the optoelectronic component (103) may be combined to form a unit with an associate electronic component (113) (shown in Figs. 6 and 8). However, Yoshimura discloses a printed circuit board element, which may have a polymer optical waveguide, electrical layers, and vias, and teaches (see col. 62, lines 28-66) that a VCSEL (optoelectronic device) with an integrated driver (electronic component) or a photodetector (optoelectronic device) with an integrated amplifier (electronic component) may also be used.

Therefore, it would also have been obvious to a person of ordinary skill in the art that the optoelectronic component (103), which is embedded in the optical layer (104) and mounted to a substrate, as disclosed by Iwaki, can be combined to form an optoelectronic chip unit with an associate electronic component, as disclosed by Yoshimura. The motivation is that a smaller footprint and higher component packing density can be realized by such integration, compared to using individual components.

Regarding claim 30, Iwaki further teaches (par. [0065]) that some layers can be made of a light blocking material. Such material would absorb light. It would have been obvious to a person of ordinary skill in the art that if a substrate layer is made of a light blocking material, then a cover layer comprising an optically transparent material and acting as an optical buffer would be required to be applied to the substrate, in order to separate the light-absorbing substrate and the optical layer and avoid high optical loss. The motivation for such a substrate / cover layer combination is that both low-loss optical transmission and reduced optical cross-talk due to suppressed stray light (par. [0065] of Iwaki) can be obtained.

**9. Claim 34 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iwaki et al (US Pub. No. 2004/0001661 A1) in view of “Three-dimensional microfabrication with two-photon-absorbed photopolymerization,” by Maruo et al, Optics Letters, vol. 22, No. 2, Jan 1997, pp. 132 – 134 (hereinafter Maruo), as applied to claim 21 above, and as evidenced by Pollak et al (US Pat. # 5,255,070).**

Regarding claim 34, the Iwaki – Maruo combination teaches all the subject matter, except for explicitly stating that the optoelectronic component (103) can be produced *in situ* on the

substrate by a thin-film technique. It is noted that a great variety of thin-film techniques, such as molecular beam epitaxy (MBE) and chemical vapor deposition (CVD), are well known in the art and would have been obvious to a person of ordinary skill in the art. Therefore, it would have been obvious to a person of ordinary skill in the art that the optoelectronic component disclosed by the Iwaki – Maruo combination can be produced *in situ* on the substrate by a thin-film technique. The motivation for using a thin-film technique is that it allows a simultaneous production of a number of optoelectronic components and can achieve high integration density. Pollak provides (col. 1, lines 14 – 24) evidence that thin-film techniques (MBE and MOCVD) are routinely used for making optoelectronic components (e.g., quantum wells that are the key stone of quantum-well lasers).

**10. Claims 47 and 49 are rejected under 35 U.S.C. 103(a) as being unpatentable over Iwaki et al (US Pub. No. 2004/0001661 A1) in view of “Three-dimensional microfabrication with two-photon-absorbed photopolymerization,” by Maruo et al, Optics Letters, vol. 22, No. 2, Jan 1997, pp. 132 – 134 (hereinafter Maruo), as applied to claim 21 above, and further in view of “Two-photon polymerization initiators for three-dimensional optical data storage and microfabrication,” by Cumpston et al, Nature, vol. 398, March 1999, pp. 51 – 54 (hereinafter Cumpston).**

Regarding claims 47 and 49, Fig. 15 of Iwaki discloses an optical waveguide (105) having a certain shape, e.g., with a lens structure (109) on its end adjacent an optoelectronic component (101). Overall, the teachings of Iwaki and Maruo combine (see the arguments and motivation for modification as applied to claim 21 above) to teach all of the subject matter,

except for detailing other possible shapes and structures of the optical waveguide formed by photon irradiation, even though a great variety of waveguide shapes are well known in the art and routinely used for various reasons. In this regard, Fig. 3c of Cumpston describes the formation of 3D optical waveguide structures with a higher refractive index and shows a tapered optical waveguide that is widened in a funnel-shaped manner. It is noted that tapered waveguides are well known in the art and used for coupling to optoelectronic components, such as semiconductor lasers. Cumpston further states (page 53, 3<sup>rd</sup> full paragraph) that the produced waveguide structures can be photonic bandgap structures, which are also known as photonic crystal structures. The latter are well known in the art as being capable of providing light confinement and mode shaping via a variety of topologies (lenses, tapers, etc.). Therefore, it would have been obvious to a person of ordinary skill in the art that the optical waveguide disclosed by the Iwaki – Maruo combination can have various shapes and structures, including those recited by the claims and illustrated by Cumpston. Tapers are known to improve optical coupling between optical elements with different mode sizes, while photonic crystals additionally provide tight light confinement and enable sharp transitions, thereby minimizing a device footprint.

### ***Conclusion***

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ROBERT TAVLYKAEV whose telephone number is (571)270-5634. The examiner can normally be reached on Mon - Thur 9 am - 6 pm EST.

Art Unit: 2883

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Frank Font can be reached on 571-272-2415. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Robert Tavlykaev/  
Patent Examiner, Art Unit 2883

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9/14/09  
FGF/rt